Washington Photometry of New Globular Clusters in M31

Sang Chul Kim, Myung Gyoon Lee

Astronomy Program, SEES, Seoul National University
Seoul 151-742, Korea

Doug Geisler, Juan Seguel

Departamento de Física, Grupo de Astronomía, Universidad de
Concepción, Casilla 160-C, Concepción, Chile

Ata Sarajedini

Astronomy Department, University of Florida, Gainesville, FL
32611-2055, USA

William E. Harris

McMaster University, Dept. of Physics and Astronomy, Hamilton ON
L8S 4M1, Canada

Abstract. We present a progress report on Washington photometry of several hundred new globular cluster (GC) candidates in M31 which were recently found from our new CCD survey of GCs. Washington CMT_1 filters we used are very efficient to survey extragalactic GCs and to estimate the metallicity of GCs. Preliminary color-magnitude diagrams and color-color diagrams of the new GC candidates and known GCs in M31 are obtained.

M31 is the nearest giant spiral galaxy that contains more GCs than our Galaxy and all the other Local Group galaxies combined. Since there has been no CCD survey of GCs in M31 for the entire field of M31 ($> 3° \times 3°$), the luminosity function of M31 GCs in the present literature lacks data at the faint end compared to that of our Galaxy. Therefore, we have performed a new wide-field CCD survey of GCs in M31 over the past few years (Lee et al. 2001).

Here we present a preliminary Washington photometry of new GCs in M31 discovered recently in our new survey. Our photometry is based on the CCD images obtained using the KPNO 0.9m telescope + T2KA 2048×2048 pixel^2 CCD (each $23.'2 \times 23.'2$) with Washington C, M, T_1 filters. We have derived the photometry of the objects in the CCD images using DAOPHOT II/ALLFRAME.

New GC candidates in the list of objects with photometry were selected as follows. First, we plotted the color-magnitude and color-color diagrams of all the point sources detected in each field, and took the objects in the regions where GCs are supposed to be (Harris & Canterna 1977). Second, we performed the digital classification using three morphological classification parameters (wing moment r_1, central concentration r_{-2}, and magnitude difference between PSF fitted magnitude and aperture magnitude Δ mag). Third, we performed visual
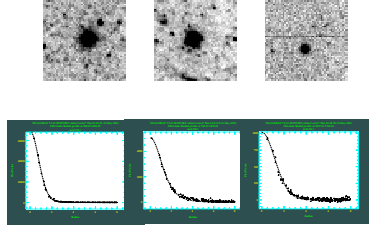
Figure 1.   (Upper panel, from left to right) T_1 images ($34'' \times 34''$) of a star ($T_1 = 14.3$, $C - T_1 = 1.2$), a known GC (315-038, $V = 16.3$, $B - V = 0.4$), and a new GC candidate ($T_1 = 19.3$, $C - T_1 = 1.4$). (Lower panel, from left to right) Radial profiles of the star, the known GC, and the new GC candidate. Note that the FWHM of the star and the typical FWHM of the image is 1.8 px. The FWHM of the known GC is 2.6 px, and that of the new GC candidate is 2.8 px.

examination of the images using the radial/contour profiles and surface plots of the objects (Fig. 1). Finally the photometric candidates are to be confirmed spectroscopically.

Figure 2 shows the color-magnitude and color-color diagrams of the resulting ~ 1000 GC candidates. From the search processes described above, we assigned class to each object: class 1 for probable GCs, class 2 for possible GCs, and class 3 for doubtful GCs. There are ~ 100 class 1 candidates, ~ 500 class 2 candidates, and ~ 400 class 3 candidates in Figure 2. There are seen more objects in the fainter part ($T_1 > 18$ mag) than in the brighter part, probably due to the presence of non-GC objects. When the objects in this plot are confirmed as genuine GCs from spectroscopic observations (Lee et al. 2001), the fainter part of the luminosity function of M31 GCs is expected to be filled, especially at $18 < V < 20$ mag (i.e. $18.5 < T_1 < 20.5$ mag).

The color-color diagram shows that the new GC candidates (class 1) are located along the sequence of the known GCs in M31 and our Galaxy, indicating that most of class 1 objects are probably the genuine GCs in M31. The large scatter for the M31 GC candidates is expected to be reduced, when aperture photometry is used instead of the PSF fitting photometry which was used temporarily in this presentation. We will finally use aperture photometry of the GCs for the analysis of luminosity functions and metallicity distribution of M31 GCs.

References

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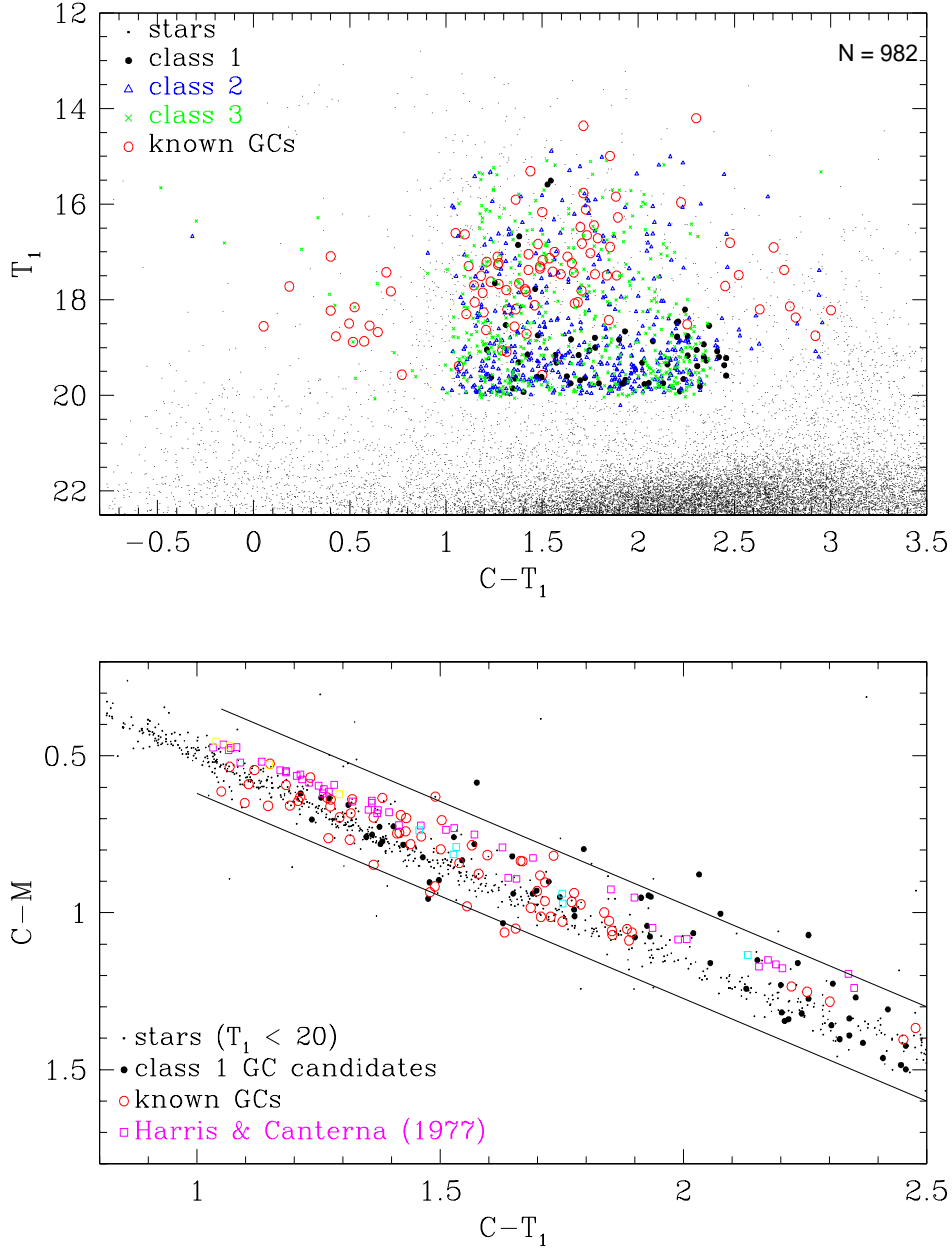
Figure 2. Color-magnitude diagram (upper panel) and color-color diagram (lower panel) of new GC candidates. Stars of one field are plotted as small dots. Class 1 (probable GCs), class 2 (possible GCs) and class 3 (doubtful GCs) objects are plotted by filled circles, triangles, and ×'s, respectively. Open circles present ∼ 100 known GCs in M31. Open squares in the color-color diagram are GCs in the Galaxy, Fornax dSph, and M31 taken from Harris & Canterna (1977). Objects deviating much from the main locus need further checking.